Dimming Controllers Offer Potential Energy Savings in Outdoor Lighting

Lighting control technology reduces energy consumption by dimming during off-design operation

Figure 1: U.S. at Night (Photo Credit: Data courtesy Marc Imhoff of NASA GSFC and Christopher Elvidge of NOAA NGDC. Image by Craig Mayhew and Robert Simmon, NASA GSFC., http://visibleearth.nasa.gov/view_rec.php?id=1438)

Parking areas are lit for safety and security. Adequate lighting can provide comfort to the user, traffic safety, personal protection, convenience, and can provide for business attraction. Night-time lighting can also be a significant energy consumer (see Figure 1). The illumination requirements of a parking facility depend on the type of usage the facility receives, which reflect both traffic density and intensity.

Presently, the most prevalent outdoor lighting is high-intensity discharge (HID), such as high-pressure sodium (HPS) and metal halide (MH). In addition, induction fluorescent and light-emitting diode (LED) may also be used for outdoor lighting.

Introduction

The Commissary at the Naval Base Ventura County located at Port Hueneme, California, shares a large parking area with the adjoining Navy Exchange (NEX). The Commissary's hours of operation vary by the day of the week, but the store may be open to customers as late as 7:00 P.M. The Commissary, however, employs a night shift that restocks products and cleans the store. The Commissary's parking area is lit with 17, 400-Watt high-pressure sodium lamps in conventional shoe-box-style luminaires (Figure 2). An astronomical time-clock system is used to control the operation of the outdoor lights. In general, the parking area lights are turned on at dusk and off at dawn providing for a well-lit parking area.

In this Fact Sheet:

Investigating ways to reduce energy consumption and costs, the Navy's Technology Validation (Techval) Program, with support from the Department of Energy, Federal Energy Management Program, sought to demonstrate new lighting control technologies that offered potential energy savings for outdoor lighting applications.

HID Dimming

Energy consumption is reduced when lighting is dimmed. Design light levels are desired when the Commissary is open for business and the activity level in the parking area is high. After customer hours, the activity level is much lower and the light level can be reduced, thereby saving energy.

Photo courtesy of PNNL

Figure 2: Parking Area Lights at the NBVC Commissary

There are various technologies that can be used to dim HID lighting, including dimming ballasts and centralized voltage-control systems. One advantage of centralized voltage-control dimmers is they are compatible with constant-wattage autotransformer (CWA) ballasts, a common ballast type found in existing HID luminaires. Centralized dimming controllers can, in some applications, reduce the total installation cost because installation can be accomplished by placing one central dimming controller at the main power supply instead of replacing existing ballasts with dimming ballasts in each of the elevated light fixtures.

In this demonstration activity, the Navy sought to determine the effectiveness of three different centralized HID dimming technologies with user-adjustable capabilities: Globalight, LightBoss, and Sinewave. A fourth product was also tested but was not user adjustable; therefore, it was excluded from this summary. Each of the devices apply full voltage to the lighting circuit to start (strike) the HID lamps. Then, after allowing the lamps to warm up and stabilize, the device reduces the voltage, which dims the lamps and saves energy.

While each centralized HID dimmer is similar, they also have several differences in how they operate internally and the options they offer. The purpose of this demonstration was not to identify which product is best or to endorse one product versus another. Instead, the purpose was to determine the extent to which centralized HID dimming can be effective in reducing power (and thereby energy consumption) and validate the associated loss in illumination while dimming. The reader is encouraged to investigate the individual advantages and limitations of the various products to determine which is best for their specific application.

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There are a few different ways to take advantage of the opportunity HID dimming technology offers. The Illuminating Engineering Society of North America (IESNA) illumination standard for open parking areas identifies a basic minimum horizontal illuminance of 2 lux (0.2 footcandles) and an enhanced security minimum horizontal illuminance of 5 lux (0.5 footcandles). The Handbook also acknowledges that some merchants prefer higher levels of illumination, such as a specification of 10 lux (1 footcandles) as a minimum value. However, the standard also acknowledges that during periods of nonuse, the illuminance of certain parking facilities may be turned off or reduced to conserve energy. Reduction should not be applied to facilities subject to intermittent night use. If reduced lighting is to be used only for the purpose of property security, it is desirable that the minimum (low point) value not be less than 1 lux (0.1 footcandles). (IESNA Lighting Handbook: Reference and Application, ninth edition, Figure 22-21.)

Therefore, one opportunity is in parking areas where the activity level does not warrant full illumination during periods of nonuse but the installation does not want to completely turn off the lights. For example, a Commissary parking area may warrant full illumination after dusk during business hours. However, after the Commissary closes and patrons have time to leave, the parking area lighting could be reduced to minimal illumination requirements. Turning off select parking are lights is an unsatisfactory option because it creates dark spots (poor uniformity ratio); whereas, dimming allows the illuminance to be reduced uniformly while realizing a reduction in energy consumption.

The Commissary lighting system with the centralized dimmers performed notably well when the 400-Watt high-pressure sodium lamps were only a few months old. However, the lighting system was retested when the lamps were 2-years old

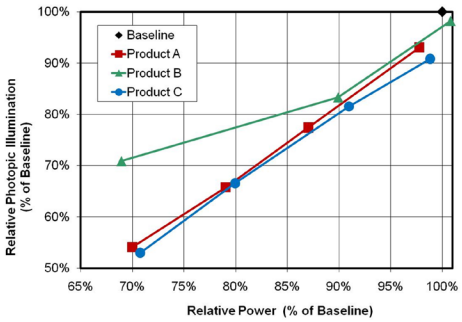

Figure 3: Illumination versus Power After 2 Years of Operation

(8,000 hours into a 24,000 hour average life). While the results are still promising, they are diminished from the initial findings. Initially, the lights appeared to save energy with equal proportion to the level of dimming (e.g., dim 30%, save 30%).

However, after 2 years of operation, the amount of light loss through dimming was greater. As shown in Figure 3, a reduction in power of 10% could result in a 15% to 20% reduction in photopic illumination. Some loss in illumination was present even when the HID dimmers were in by-pass mode. While manufacturers claim the capability to dim by 30, 40 and in one case up to 50%, this demonstration showed all three products were limited to a 30% reduction in power. Trying to dim below this level resulted in select lights becoming unstable and going out. This limitation may be a function of the age and type of ballast. The centralized dimming controllers are compatible with several different types of HID ballasts; this demonstration involved CWA ballasts of unknown age.

The cost of the technology will vary relative to capacity, configuration, features and options. For this demonstration, which involved single-phase 277-volt with a 30-amp capacity, the equipment cost ranged from $2,445 to $4,226 with an additional $1,280 for contractor installation.

Conclusions

HID dimming for outdoor parking areas shows the potential for reducing energy consumption. The technology does have some limitations and performance may change as lamps age. However, in applications where the level of activity can vary, dimming during periods of lower activity can save energy. While different manufacturers may use different internal components, the technology appears to be sound. Each of the products tested was easy to install. Different products offer different features and options, and products are available in a wide range of capacities. It is important to know if the product is compatible with the specific ballast types being used. The primary differences that will be of interest to Federal energy managers are features and cost. In some cases, centralized HID dimmers can be tied into existing building automation systems (BAS) or energy management control systems (EMCS), whereby the timing and power reduction strategies can be remotely controlled.

For More Information

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